ACCEPTANCE STANDARDS

PART ONE

Part one consists of OTDR trace data in the form of pigtail and bi-directional span shots. Bi-directional averaged OTDR data and pigtail shot analysis will be used to determine final acceptance of the fibers. A final document containing splice locations and distances, averaged splice losses, and Power Meter / Light Source tests will be given to the customer upon project completion.

Pigtail Trace Data

Upon completion of cable termination the pigtail tests will be performed. A 1-km launch reel of matching glass type to the backbone cable will be attached between the OTDR and the pigtail. The loss of the pigtail splice and connector will be measured and recorded at 1550nm. OTDR traces of all pigtail splicing will be stored on diskette/CD**.**

The loss value of a pigtail connector and its associated splice with matching mode field diameters should not exceed 0.5 dB at 1550nm. The loss value of a pigtail connector and its associated splice with mismatched mode field diameters should not exceed 0.7 dB at 1550nm. Pigtail traces for all terminations will be provided.

Bi-Directional Trace Data

Bi-directional OTDR traces will be taken with or without a launch reel depending on the customers testing requirements. Traces will not have a launch reel attached if not requested by the customer. OTDR traces will be taken in both directions at 1310 & 1550 ηm unless otherwise stated by the customer. Loss measurements for each splice point to be measured and recorded in both directions. The loss values for the splices will then be averaged. The loss for a splice should not exceed a value of 0.10 dB when bi-directionally averaged with traces taken at 1550 ηm. Splice losses that exceed 0.10 dB with be re-spliced to bring the fiber into specification.

NOTE: These measurements WILL BE MADE AFTER THE SPLICE HANDHOLE OR MANHOLE IS CLOSED in order to check for macro-bending problems.

Mass Fusion Splicing

Ribbon Fiber Bi-directional Splice Loss Standards

Fiber Type	Splicing Method	Splice Loss (dB)
Standard Single Mode	Mass fusion splicing	0.20 dB
Non-zero Dispersion-shifted	Mass fusion splicing	0.25 dB

In the event that the splice loss values listed cannot be achieved the ribbon containing the OOS fiber(s) will be broken and re-spliced. The re-splice procedure and acceptable values are listed in the table below.

Mass Fusion Re-splice Acceptance

Ribbon Fiber	Standard Single Mode	Non-zero Dispersion Shifted
Splicing Method	Mass fusion	Mass fusion
Acceptance Criteria	0.20 dB	0.25 dB
After 3 attempts	0.30 dB	0.30 dB
After 2 additional attempts	0.40 dB	0.50 dB

Note: Five (5) attempts are to be performed and all non-successful splices will be recorded on diskette/CD.

File Naming Convention

All OTDR traces taken will follow an understandable file naming system. Traces will have an 8-character file name plus a 3-character file extension. An example of a completed file should contain the following information:

- First four characters = trace origin
- Characters 5 - 7 = end location
- Eighth letter = wavelength (3 = 1310, 5 = 1550, P = pigtail)
- . Period
- . Extension = fiber number

Example: OTDR trace fiber 96 from Dallas to Ft. Worth at 1550 = DLLSFTW5.096.

Note:
OTDR HEADER INFORMATION WILL BE COMPLETED FOR EACH TRACE. PRIOR TO THE START OF ANY TESTING, ALL CONNECTORS WILL BE CLEANED WITH A CONNECTOR CLEANER.

PART TWO

Power Meter/Light Source Testing

A bi-directional End-to-End test will be performed on each fiber in a span at 1310 and 1550 ηm with a Light Source and Power Meter. This test will determine the actual span loss and continuity of all fibers. All equipment will be referenced prior to field use.

Bi-directional span loss readings should not have a greater than %10 difference. If a %10 or greater difference exists in a set of readings, attempts will be made to remedy the anomaly causing the difference. B&M will remedy any “frogs” or fibers not having continuity and bi-directional anomalies in the plant prior to fiber acceptance.

Acceptable Span Loss Calculation Method

(A * L) + (0.1 * N) + C = Acceptable Span Loss	
A	Attenuation per km at 1550 nm
L	Optical length of cable measured in kilometers (from OTDR Trace)
N	Number of splices in a span
C	Connector loss. The loss will not exceed 0.5 dB per connector. The fiber will have two (2) pigtail connectors/splices under test, so 1.0 dB will be allowed for this loss.

ALL CONNECTORS WILL BE CLEANED BEFORE POWER METER / LIGHT SOURCE TESTING. CLEANLINESS CAN DRAMATICALLY AFFECT THE LOSS VALUES FOR A GIVEN FIBER UNDER TEST.

OTDR Setup

The OTDRs used by B&M Telecom are Nettest CMA 4000 units. The 4000 units are calibrated at proper service intervals to insure proper working order.

Index of Refraction Table

Fiber Type	1550 nm	1310 nm
AT&T Tru Wave	1.4700	1.4659
AT&T Depress Cladding	1.4670	N/A
Lucent TW-RS	1.4700	1.4710
Corning SMF-28	1.4681	1.4675
Sumitomo	1.4670	1.4670
Corning SMF-LS	1.4700	1.4710
LEAF	1.4690	N/A

Test Packages

B&M Telecom shall provide a package containing the following test data for each fiber. All data provided should be saved on diskette/CD and given to the customer upon completion.

A. OTDR span traces taken at dual wavelengths.
B. Pigtail traces taken for each fiber.
C. An Excel spreadsheet containing the power meter and light source data for both directions at 1310 and 1550 ηm. Data should also include the average for each fiber.

PART THREE

B&M Telecom can provide specialized testing for CD / PMD based on customer requirements. Optical Return Loss data is also available.

Polarization Mode Dispersion Testing

Polarization Mode Dispersion is a phenomenon that describes the separating of an individual pulse traveling through an optical fiber. PMD is caused by changes in geometry and purity of the core of a fiber. The effect of PMD is that different portions of pulses arrive at slightly different times and make it difficult for the receiver to identify the signal. This effect is more detrimental to high bit rate systems due to overrun of pulses. A 10gbit/sec system has less distance between pulses of light than a 2.5gbit/sec system. Overrun occurs when the leading portion of the following pulse catches one portion of a preceding pulse. PMD is most common in cables manufactured before 1992 and has more effect on longer spans because it is a function of distance. The next table shows the specifications of PMD versus Bit rate.

Maximum PMD per Bit Rate		
PMD	1550nm Test	
Bit Rate (GB/s)	Delay (ps)	Coef (ps/√km)
2.5	40	<2.0
10	10	<0.5
20	5	<0.25
40	2.5	<0.125

Each fiber will be tested 3 times and averaged due to the inconsistent nature of PMD. Testing will be performed using Exfo FTB 5700 platform equipment.

Optical Return Loss Testing

Optical return loss is the total return loss from all reflective points looking outward from the equipment. Poor ORL can cause high bit error rates due to excessive signal noise and feedback to the transmitter. Most DWDM equipment requires ORL to be better than 24dB, however the specification is usually written as >27dB. ORL is tested from each end on all fibers due to its uni-directional nature. B&M uses EXFO ORL meters.

Chromatic Dispersion Testing

Chromatic Dispersion is similar to PMD in that it describes the separating of an individual pulse traveling through an optical fiber. However, CD is caused by changes in index of refraction (IOR) of the fiber core and cladding. The changes to the IOR of a fiber cause portions of light pulses to change speed. The portion of the pulse effected by the change separates from the rest of the pulse and can cause bit error. CD is also linked to the transmit laser characteristics. Most lasers do not emit single wavelength signal pulse. The pulses are

usually emitted in a small wavelength window. The different wavelengths contained within one signal pulse travel at different speeds through the fiber and again can cause separation. The effect of CD is similar to PMD as well.

It is more detrimental to high bit rate systems and has more effect on longer spans because it too is a function of distance. The next table shows the specifications of CD versus Bit rate.

Total Allowable CD per Bit Rate	
1550nm Test	
Bit Rate (GB/s)	(ps/km)
2.5	12,000 to 16,000
10	800 to 1000
40	60 to 100

The wavelengths tested include the C and L band wavelengths. This test will be performed using Exfo 5700 platform equipment.